On the Verification of the Constants employed in the Uranometria Nova Oxoniensis. By the Rev. Professor Pritchard, D.D., F.R.S.

In the *Monthly Notices* of March last Dr. Spitta throws some doubt as to the method employed in determining the coefficient of absorption of the Wedge Photometer used for the purposes of the Uranometria Oxoniensis. If I understand his criticism correctly, he doubts whether a proper diaphragm was applied to the Nicol prism in the apparatus constructed for deriving the coefficient aforesaid. He found, it appears, that in his own case the proper use of a proper diaphragm removed some sources of error, and that he thereby secured results coincident with others obtained by a different photometric process which he regards as free from error.

With regard to the accuracy of the two Oxford wedges described in the *Memoirs R.A.S.*, vol. xlvii., and used for the purposes of the Uranometria, I had in effect but little anxiety. These wedges are of very different steepness, and the coefficient of absorption of each was independently obtained from nearly three thousand distinct measures;* for I was more anxious to secure accuracy than to save time usefully expended. Still, after Dr. Spitta's remark, I felt it my duty to re-examine one of the two wedges; and I duly attended to his remarks as to the necessity of using a proper diaphragm in order to obviate the internal and other reflections which he regards as the source of error in his own case. The result was that no correction could possibly be made in the coefficient of absorption of the wedge used for the Oxford Uranometria. The method employed for the re-examination of this wedge was an improvement on that used in 1882, and one whereby any accumulation of small errors was avoided; which errors, if they existed, would arise from the smallness of the interval of the wedge, examined step by step by the old process of 1882. In fact it was to avoid these possible errors, which led to the employment of so many thousand applications of the instrument.

The results obtained by the two distinct methods of examination for the absorption (expressed in stellar magnitude) at each successive inch of the wedge is shown below.

* Moreover, I had observed that the Nicol Prism employed for obtaining this constant, was perfectly free from stilbite, or other silicates, and allowed no light whatever, perceptible to the eye, to pass through it when in the position of zero. I may here add, too, that a very scrupulous examination was instituted in regard to the absorptive power of the wedge in the case of red, orange, green, and blue lights. The absorptive power was practically the same for them all. See *Memoirs Roy. Ast. Soc.*, vol. xlvii. p. 395.

Inch.	1882. Mag.	1890. Mag.
1	1·93	1·93
2	3·81	3·89
3	5·69	5·62
4	7·52	7·53
5	9·30	9·41
6	11·07	10·95

Experiments were also made to ascertain the effects of diminishing the aperture of the diaphragm used between the eye and the Nicol. The result was that, as used at Oxford, any material alteration in the diameter of this aperture introduced errors which had not existed before. In order that no mistake should be made in the question of diaphragm, the assistance of Mr. Selby, the demonstrator in the Clarendon Physical Laboratory at Oxford, was invoked, and his independent conclusions coincided with those of Mr. Plummer and Mr. Jenkins.

I take it, therefore, that the coefficients of absorption of the two Oxford wedges are, so far, established as correct. But this is by no means the whole of the case.

Dr. Spitta's objections in reality do not apply solely, or even particularly, to the Wedge Photometer, but to every species of photometrical measure hitherto made by means of the properties of polarised light. They implicitly apply to instruments used by Zöllner, Lindemann, Ceraski, Pickering, and other physicists; but inasmuch as Dr. Spitta finds that on the use of proper precautions the method of polarisation does give the same results as those arising from what he regards as superior methods, I need say no more on the generic question of the instrument or the method used for the evaluation of the coefficient of absorption of a wedge.

I may add also that, in order to extend my own work to stars too faint for the two wedges hitherto used in the Oxford Observatory, I had requested Mr. Hilger to undertake the formidable task of constructing as thin a wedge as he, with all his skill, could effect. In due time I received this excellent instrument, and I found it now applicable to the extinction of stars of mag. $11\frac{1}{2}$, as used with the Oxford $12\frac{1}{4}$-inch object-glass. I proceeded to evaluate its coefficient of absorption by the new and improved method adopted by Professor Pickering (*Investigations on Light and Heat*, No. vi. p. 323). The result was that an interval of one inch extinguished 0·97 mag. I had previously requested Dr. Spitta kindly to evaluate the same wedge constant with his best care and his best methods. His result was that 1·12 mag. was extinguished at each successive inch of the wedge. Armed with these constants, this thin wedge was applied to the heavens, and Mr. Plummer carefully observed thirty stars of the *Pleiades* from magnitude 7 to 11. The resulting magnitudes

were compared with those assigned by Professor Pickering (*Annals Harvard Observatory*, vol. xviii. pt. vii.), and it was found that the average difference of magnitude (Harvard—Oxford) was only 0·07 mag. But, on the other hand, if I used the instrumental determination furnished by Dr. Spitta, the difference between the Harvard and Oxford magnitude would amount to as much as 0·54 mag. Such a difference is wholly unknown in any comparison of my works with those of the most eminent observers.

Again, a similar process was adopted with regard to twenty stars observed by Lindemann.* The result here was that with the Oxford value of absorption the average difference (Lindemann—Oxford) amounted to only −0·05 mag. With Dr. Spitta's constant this difference is increased from 0·05 to 0·50 mag. The photometer used by Professor Pickering was his own meridian photometer, aided by photography. Dr. Lindemann used the ordinary Zöllner photometer.

I think that here also I may properly appeal to the results which Dr. Lindemann and Professor Pickering have themselves deduced and recorded from the Oxford photometry. The former says: "From thirty-three stars of the *Pleiades* the mean deviation of a single determination of relative brilliancy equals (Pr—Lind) +0·05 mag." † The latter, from the more extensive comparison with the Uranometria Oxoniensis, says: "The mean result from the 2647 stars compared is, that the average magnitude of a star in the U. O. exceeds the corresponding magnitude in the H. P. by 0·049 mag." ‡

It appears, then, from the foregoing remarks, that both Lindemann and Pickering agree in their results with the Oxford determinations. Each of these employed a method and an instrument of his own, differing from each other and from the method employed at Oxford; and, moreover, this agreement among the three astronomers would be completely destroyed if Dr. Spitta's constant of absorption were adopted.

Nevertheless, I beg to express my sincere obligations to the latter gentleman for his inducing me to re-examine the whole question of wedge photometry, and I hope also he will permit me to acknowledge my admiration of the perseverance and ingenuity with which he has carried on his own investigation.

University Observatory, Oxford:
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* Photometrische Bestimmung der Grössenclassen der Bonner Durchmusterung. St. Petersburg, 1889.

† *Op. cit.* p. 145. ‡ *Annals Harvard Observatory*, vol. xviii. p. 17.

Note on the Scaling of Dr. Spitta's Wedge by means of Photography.

By Captain W. de W. Abney, C.B., D.C.L., F.R.S.

Two or three meetings ago Dr. Spitta read a paper on the scaling of his wedge as used for astronomical purposes, and in the discussion which followed I said that wedges could also be scaled photographically. The scaling, I need scarcely say, referred to the determination of the absorption coefficient per unit of length. Dr. Spitta kindly placed his wedge at my disposal, and I must premise that until I had more than half completed my experiments I had no idea what the coefficient he had determined was, nor the unit of length for which he took it. On subsequently reading his paper in the *Monthly Notices*, I was still at a loss to know these points, as he had not expressly stated the latter, and had to ask him by letter what they were. The wedge he lent me is one cut out of what I suppose ought to be neutral tint, but which is really a species of bottle-green glass. Examining it in the spectrum it was easy to see that there was a much larger absorption coefficient in the red than in the green, and in the green than in the blue-green. Beyond that, it was unnecessary to examine the wedge in this manner. My first experiment was to determine its absorption for the rays which act on iron salts, the maximum of which lies in the blue-green rays. For this purpose I employed the ordinary platinum paper supplied by the Platinotype Company. A strip was placed in contact with the wedge and exposed to the direct light from an arc electric light, care being taken to prevent any light penetrating through the sides of it. The light was placed at such a distance from the wedge that practically the rays falling on it were parallel rays. Simultaneously, and with the proper precautions, a piece of platinum paper was exposed in a Spurge sensitometer, which I have described in a paper read before the Society last year. The papers were developed together and washed and dried, the paper having been previously marked off in $\frac{1}{4}$ inches, that all error due to shrinkage might be avoided. The sensitometer print was measured for blackness, and a curve constructed; the abscissæ used were the known intensities of light, and the ordinates the blackness, or perhaps I should say the amount of whiteness left. This was measured with my photometer in the way I have described here and in other papers. The wedge print was measured in the same way at every $\frac{1}{4}$ of an inch, and the intensities of light acting at every $\frac{1}{4}$ inch derived from the curve, the amount of whiteness indicating the intensity which had acted.

The measurements gave me the coefficient of absorption. This gave a star magnitude of 1·38 per inch.

Now evidently the value thus obtained would not be the same as the value to the eye, since it is the yellow part of the spectrum which has most effect on the latter and the